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The American
X-Ray Journal

A JOURNAL OF
Progressive Therapeutics

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Electrical Science

X-Ray Photography

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Radio Therapy

Photo Therapy

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Official Organ of The American Electro Medical Society

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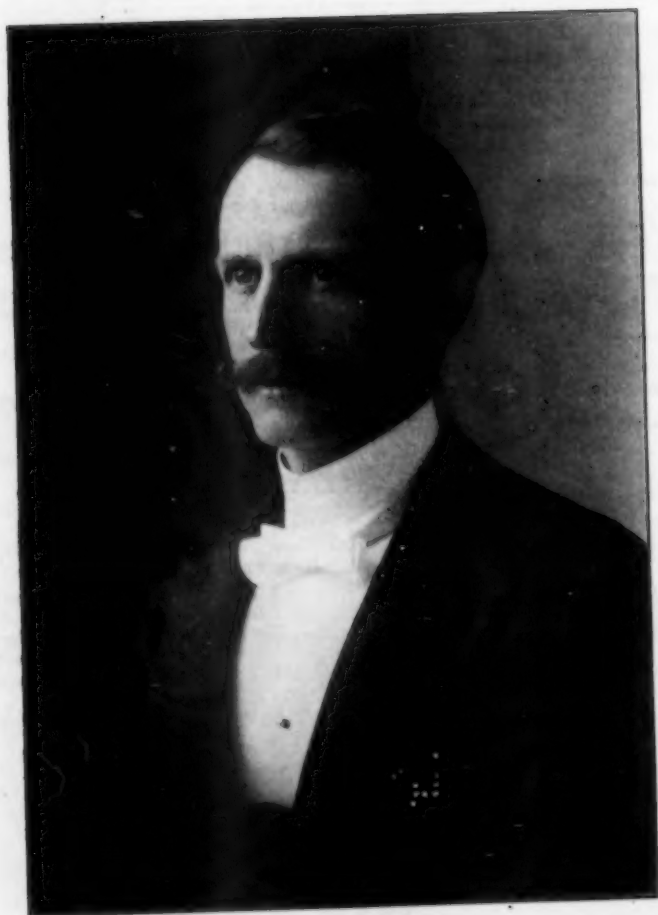
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No. 1

CONTENTS.

	PAGE		PAGE
Frontispiece. Dr. O. Shepard Barnum...	2	ELECTRO THERAPY.	
The Roentgen Ray and Surgery, by O. Shepard Barnum.....	3	Electricity in Dental Extraction.....	16
Electro Therapy, Lesson 8, The Static Machine.....	6	Electricity in General Practice.....	21
Dangers to the X-Ray Operator, by John T. Pitkin.....	9	Treatment of Pulmonary Tuberculosis with High Frequency Currents, Etc.	21
X-Ray Burns, by Robert S. Gregg.....	12	Electricity in Nervous Diseases.....	22
Galvanic Electrolysis as a Cure for Stricture of the Urethra, by J. C. Luke.....	14	RADIO THERAPY.	
A Study of Light: Ultra Violet Light, by J. Mount Bleyer.....	23	Protection Against X-Rays.....	5
ELECTRO PHYSICS.		Cancer Cured by Radium.....	17
The Electrophone.....	15	What Can be Done for Cancer?.....	17
Heating Effect of Radium Emanation..	15	Cancer Following X-Ray Burns.....	18
Roentgen Ray Tanning.....	16	X-Ray and Light Research.....	18
Power of Radium.....	17	Radio Therapy for Ozena.....	18
Screen for Ultra Violet Rays....	21	Legal Status of X-Rays.....	18
Heat Radiation of Incandescent Lamps	22	Radio Therapy.....	19
Method of Reversing Influence Machs.	22	X-Ray, Light, Etc.....	19
		Future of Roentgen Rays.....	19
		PHOTO THERAPY.	
		Violet Rays for Tuberculosis.....	20
		Finsen Light.....	20
		The Solar Cautery.....	20
		Effects of Light and Heat Rays on Temperature of the Skin.....	20

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DR. O. SHEPARD BARNUM
President American Electro-Medical Society.

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Devoted to Practical X-Ray Work and Allied Arts and Sciences.

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The Roentgen Ray and Surgery.*

BY O. SHEPARD BARNUM, M. D.
LOS ANGELES, CAL.

President American Electro-Medical Society; President Southern California Electro-Medical Society; Member Southern California Academy of Sciences; Member American Roentgen Ray Society, Etc.

The operator in electro-therapeutics must today pass between a Scylla and Charybdis—the Scylla of the skeptical and antagonistic surgeon; the Charybdis of the ultra-enthusiastic devotee of the new radio-active powers. A mid-channel course is the only safe one, and this must be the excuse for a short paper favoring a compromise between x-ray operators (among whom I am glad to be numbered) and the surgeons of the old and new schools.

Is the use of the x-ray in any degree a substitute for the knife? This question is now occupying the attention of the leading physicians and surgeons of the country, and rightly so, for its solution means much to suffering humanity. Before expressing a personal opinion, let us look at the question from two or three view-points. Our thots and conclusions will be chiefly based on an extended study and experience in the application of the Roentgen ray in cancerous diseases. Other diseases might well be considered if time permitted, but cancer is a peculiarly surgical field and the ray has been more used for this group of lesions than for any other.

Statistics show a recurrence in 70 per

cent of cases of superficial epithelioma removed by the knife, and 60 per cent fatal termination. In uterine cancers no surgeon can claim better than 25 per cent living patients who have been operated on three years previously, and 7 per cent or 8 per cent living five years after the operation. We venture to say also that a great many of these reported cases were without sufficient verity in diagnosis. Such statistics are discouraging, to say the least, but this hardly justifies the fact that the doctor and layman have jumped too hastily to conclusions as to the efficacy of the x-ray. They have done so, however, for the simple reason that with such statistics as the above in mind, it was but natural to grasp at anything which showed even a modicum of hope of bettering conditions.

State Board of Health reports indicate an increasing number of cancers, and show that at the present time in some parts of this country as many as thirty-five of each 1,000 deaths are from this disease. Is it any wonder that we eagerly reach out for any agent offering the slightest hope of reducing this great mortality? And yet this country has but little over one-half the mortality from cancer that Europe has.

The electro-therapist is no longer

* Read before the American Electro-Medical Society at its first annual meeting, Chicago, Dec. 1-2, 1903.

justified in hiding behind the cloak of the "experimental stage of x-ray work." We know what the ray can do; we know its dangers and its virtues; and tho without explanation as to just why or exactly how the thing happens, the actual results are abundant and justify prognosis. Our technic may be faulty, but our theories certainly are not false.

For the purpose of our argument we may consider the ray under the following three divisions:

1. Stimulating.
2. Inhibitive.
3. Destructive.

In contrast or comparison with surgical procedures the third division is chiefly to be considered. The direct question then arises, Is the destructive action of the ray a fair substitute for the knife in operable cases? I answer, "No." The process of *rayism*—a necrosis of animal tissue—is tedious, varying greatly because of idiosyncrasy of the patient, and the result is sometimes a destruction of too much tissue or an indolent wound which refuses to heal for months or even years. (I am not convinced as to whether this may or may not result in a degenerative cell diathesis.)

Under average conditions and with conscientious regard to the welfare of a patient, what is the proper course of the electro-therapeutist? In the majority of cases, which from our present surgical knowledge would be classified as operable (with some of the exceptions hereinafter mentioned), I believe the surgeon's aid should be enlisted, for the following reasons:

1. To expedite the work.
2. For the comfort of the patient.
3. To prevent possible septic conditions.
4. To insure against too extensive x-ray necrosis.

Every thinking man will concede the first point. The immediate removal of a tumor by the knife in contrast to either of the necessary processes of Roentgen ray treatment—absorption or ulceration—is most certainly in favor of surgical procedure.

The same reasons hold good for the second point—the comfort of the patient. By the use of the knife we have in most instances to use the ray on a closed wound instead of an open one, thus lessening discomfort, odor, bandages, etc. Patients may by this combined treatment be able to continue employment where otherwise they would be confined to the house. Very few patients will refuse operation when the matter is plainly put before them.

Almost every x-ray operator has seen the process of absorption so stimulated by the application of the ray as to bring in many cases a fatal toxemia. The only alternative to this is a conservatism which may defeat its own ends by discouraging the patient, leading to carelessness and neglect, or reducing its efficiency by tolerance, even to the stage beyond possibility of help by any means.

The fourth point refers to a destruction of tissue beyond what is necessary, or a typical x-ray necrosis in tissue remaining after the diseased portion is fully eliminated—one of those bugbears that the operator dreads beyond words to express. Most radical measures are necessary to heal them, and months pass with so little progress as to try the doctor's patient and patience to the last degree.

In short, I believe that the combination of the two methods is better than either alone. If there exists a suppositious involvement of surrounding tissue and lymph channels, proper drainage can be left in the surgical wound to insure the full effect of the ray following with-

out danger of toxemia. If necessary to preserve the continuity of muscle, nerve or vessel, the knife process can be well curtailed and dependence put on the applications of the ray to immediately follow the operation. In cancer of the breast, for instance, the knife might entirely remove the ulcer and contiguous indurations, leaving a possible involvement of the pectoral muscles, the glands and tissue of the neck, and possibly of the axilla, for the action of the ray.

I have seen many instances where the palliative operation with the knife to remove danger of infection would have been very desirable if the ray could have been applied immediately after, and tho in these instances no permanent cure could be expected, the result would have been a prolonging of life and materially smoothing the rough road to the final end.

In my experience I have seen no ill-effects from the use of the ray before a surgical operation, altho I have considered and studied the possibility of such very closely. I am convinced that in malignant conditions the ray should invariably follow the knife as a prophylactic measure, nor should it be delayed until a recurrence is manifest; and I do not hesitate to use it conservatively prior to operation.

I do not want to be understood, or rather misunderstood, as saying that there are no cases for the ray alone—far from it. The question of securing the aid of a surgeon revolves about the question of degree in progress of the lesion, its position, character and status from a surgical view-point. A summary of my thot would perhaps be that the ray should be used:

1. In all inoperable cases.
2. In all purely superficial lesions, either to follow the knife or alone.

3. In all cases where there exists a doubt of malignancy. This for its inhibitive power and value as a means of promoting absorption.

4. Always to follow operations for malignant conditions.

5. Alone in primary lesions of small extent and superficial.

6. In all recurrent malignant growths.

7. As a palliative measure in all cases with a fatal prognosis.

All honor to the great discovery of Roentgen and its advance into physiological therapeutics, but let us curb our natural enthusiasm, or at least make it subservient to a true spirit of scientific search for demonstrable facts, taking from each new advance in knowledge what is compatible with accepted truths, and thus making our mixture the better for the new ingredient.

Protection Against the X-Rays.—

The danger to which an operator is exposed by employing his own hand or arm as a test object in gauging the quality of his tubes has led to the production of numerous protective devices. None of these has fully met all indications. Carl Beck (*Berl. klin. Woch.*, Aug. 10, 1903) publishes an ingenious suggestion, which consists in the substitution of a prepared skeleton of the arm for that of the operator. These bones, properly mounted, may be attached to a piece of pasteboard or other material transparent for the x-ray. The shadows of the bones, just as in the living member, are black when soft tubes are used, and light gray when the harder tubes are employed. This test object may be readily manipulated by the operator, without the latter coming within the radius of action of the rays.—*Med. News.*

Electro Therapy.

A Course of Twenty-four Lessons under the auspices of the Chicago College of X-Ray and Electro Therapeutics.

LESSON 8.—THE STATIC MACHINE.

When two non-conductors are rubbed together and immediately separated, both surfaces are found to be electrified, one positively, the other negatively. The surfaces are also said to be "charged." The sum of the two charges, however produced, is always zero.

An insulated metal ball connected with the positive pole of a battery becomes positively charged. If another conductor is made to touch the charged ball, a positive current passes from the ball to it, and the second conductor, if insulated, receives a part of the charge. A charge passes easily, without contact, to or from a metallic point. By means of one or more metallic points a charge may be distributed from a conductor to a non-conducting surface, such as glass or mica, or collected from such a surface and concentrated upon a metallic ball.

An electric charge is a strain of some kind involving the atoms and the adjacent ether. According to the vortex theory this strain is a simple twist, such as is produced in a piece of rubber or other elastic substance when one end of it is held firmly and the other end rotated. A positive current, being a right-handed rotation, makes a right-handed twist, which, when the twisting force (electro-motive force) is removed, makes a positive current from that surface. Similarly, a negative charge is a left-handed twist, produced by a negative force and giving rise to a negative current.

Tho an electric current is always both positive and negative, a charge is either positive or negative, but can not be both. A little reflection will make it clear that the twist in a positive charge is like that in a left-handed screw, and the twist in

a negative charge is like that of a right-handed screw. The sum of equal amounts of the two twists (charges) is necessarily zero.

The potential of a charge is the electro-motive force required to produce it or to balance it so that there shall be no current either way in a conductor in contact with it. Every part of a conductor (in which there is no current) has the same potential, but the potential decreases as we recede from the charged surface. The electro-motive force in any given part of an electric circuit is the difference of the potential of the two ends of the part.

A static machine is a device for producing currents of very high electro-motive force. Incidentally, there are produced at the same time charges of equally high potential. The charges are in themselves of no therapeutic value whatever. The currents are very valuable.

The various types of static machines and their modes of action are fully described in nearly all text books of electricity, and are only mentioned here. The friction machine consists of a glass plate or disk mounted so as to be rotated by a handle. The charges are made by the friction of an amalgam rubber, which presses against the plate. The positive charge is collected from the plate upon a large rounded metallic conductor. The machine is of little use therapeutically.

The Holtz machine acts by induction only. It is very efficient, but must be charged each time to start it. In all induction machines one-half of the revolving plate carries positive charges at the same time that the other half is carrying negative charges, doubling the current capacity of the machine.

The Toepler-Holtz machine is a modification which makes the machine self-starting.

The Wimshurst machine is self-starting, acts by induction and is efficient. It has two disks, which rotate in opposite directions. It is used much more widely in Europe than in America.

The value of a static machine depends much more upon the details of its construction than upon the type selected. It goes without saying that the mechanical construction must be first-class in every particular. A very fair-looking machine may be made which will give excellent service for a few weeks, but in a short time the metallic parts become rusted, the brushes and combs displaced, the bearings run hard, the glass disks get loose or strike each other, the case no longer fits so as to be airtight, and the whole machine has a decrepit appearance. Points of this kind are best guarded by purchasing a machine from known and reliable makers, under a guarantee of such construction as will avoid such premature old age. A well-built static machine, with reasonable care, should keep in good order for five years at least. The small metallic brushes will wear out in a few months if the machine is used much, and must be replaced by new ones. Some oil or vaselin (petrolatum) must be applied to the bearings several times a year. Dust will collect on the inside of the case as well as on the outside, and must be wiped off. The shellac on the glass plates, if of a poor or medium quality, may need occasional renewal. Lastly, but not by any means least, the interior of the machine must be kept dry.

Some makers claim that by the use of materials of a superior quality their machines will work well without any special drying apparatus. However this may be, there is no doubt that any static machine

will do better work when dry than when damp; and a great many machines will not work at all unless kept reasonably dry inside. There are several ways of keeping a machine dry, and here also it is more important that one of the plans should be well executed than that any particular plan should be selected.

For a temporary dryer nothing excels a freezing mixture. A covered tin can is filled with a mixture of crushed ice and salt (ice two-thirds, salt one-third). This is wiped dry, placed inside the case of the machine, and the case closed. In from ten to thirty minutes the greater portion of the water vapor in the case has been frozen on the outside of the tin, and the machine is ready for business. The tin must be removed before the ice on the outside of it begins to melt. The larger the tin the quicker and more certain the result. Not less than two liters of the mixture should be used. This plan is good for an emergency, or when no other good drying material is at hand; but it is not satisfactory for regular use.

A simple and cheap permanent dryer is made by enclosing twenty to fifty pounds of freshly-burnt quicklime, in an airtight box, which is in communication with the interior of the machine. The lime must be replaced by a fresh supply as often as it becomes slacked. If there is room it may be placed in an open box on the inside of the case.

Another plan which is very satisfactory is to place one or two pounds of pure calcium chlorid in an open dish of glass or porcelain. The chlorid must be fused, not crystallized. It is efficient until it has absorbed so much water that it is completely dissolved in it. If the water is then driven off by heat the calcium chlorid is as good as new.

Another plan is to place in an open and deep glass vessel two or three pounds

of strong sulfuric acid. This absorbs water quite strongly until its volume is increased by one-half. It must then be replaced by a fresh portion.

Instead of sulfuric acid caustic potash may be used, and like the calcium chlorid it is efficient as long as any of it remains undissolved.

If cheap and impure chemicals are used gases are liable to be given off which may corrode the metallic parts of the machine or soften the shellac on the plates. It is particularly necessary to call attention to the danger of using "chlorid of lime" instead of calcium chlorid. Sometimes drug clerks imagine the two to be identical.

The material of which the plates are composed is of little consequence from an electrical standpoint, so long as they are good insulators. Glass, mica, vulcanite, gutta-percha are from this standpoint equally satisfactory. The durability of the plates and their original cost are the items for consideration. A well-balanced glass plate can be run at a speed of five or six hundred revolutions a minute. The ordinary glass plate will not safely go beyond three hundred. A mica or vulcanite plate is much more expensive, but can be run at a speed of nearly two thousand.

The electro-motive force of a static machine depends upon the diameter of the plates and the degree of insulation of its various parts. In ordinary machines the electro-motive force varies from half a million to a million or more volts. The electro-motive force required to make a spark across one inch of air varies much under different conditions. It has been estimated as low as twenty-five thousand volts and as high as one hundred thousand. The latter number is the nearer correct.

The current delivered by a static machine depends in part upon the resistance of the circuit, in accordance with Ohm's law; but the maximum current delivered by a machine is limited by the amount of surface of the revolving plates which passes the toothed combs in a second, as well as by the intensity of the charge upon the plate. Other things being equal, a machine with eight revolving plates will give twice the current that can be obtained from a machine with four revolving plates. But if the four plates are run at twice the speed of the others the current produced by the two machines will be nearly equal.

Two static machines may be connected together in the same way as two cells of a battery, and the same laws of current and potential apply. If the similar poles of two equal machines are connected together the resulting current has the same electro-motive force as before, but its amperage is doubled. If the machines are connected in series, that is to say, the positive pole of one machine with the negative pole of the other, so that the electro-motive forces of the two are acting in the same direction in one circuit, the electro-motive force of the resulting current is twice as great as before.

A machine having sixteen plates (eight revolving) or less can be operated by hand if necessary. Larger machines must have some mechanical motive power. Water power, if available, is very satisfactory. Gasoline or steam engines are frequently used. Electric motors, both for direct and for alternating currents, are much more convenient than engines, and are not liable to get out of order.

Dangers to the X-Ray Operator.*

BY JOHN T. PITKIN, M. D.

BUFFALO, N. Y.

When for the first time one beholds an x-ray tube in operation, the mild green or yellowish color of its active hemisphere, the blood red or orange color of the inactive hemisphere which can be obtained with strong condenser discharges, the ruby redness of the target, or the light blue color of the kathode stream, a blue cloud hovering behind the target, the green circular aurora borealis or green scintillating radial aurora australis, the bright green dancing spots of the kathode splash, the circular green zone of the tube reversed, the bluish twinkle of its fading light, the slower dying out of the incandescence of the target and the target's own modicum of ordinary light, the ever-changing, ever-expanding circle of colors on the kathode cup, the bluish marking of the tube which has seen much service, and perchance the pyrotechnical display of the punctured tube, he is liable to exclaim, How beautiful!

As he observes the delineation of bones, viscera, or foreign bodies upon the fluorescent screen or photographic plate, its curative power in skin affections, painful disorders, cancerous, tubercular and other malignant diseases, he will in all probability say, How marvelous!

Should he strive to fathom its physics, its *modus operandi*, he asks himself of what form of matter the kathode and the anode streams consist; whether in the working of the tube there is transmutation of matter from one elementary form into others, or of matter into energy. All the colors of the rainbow are de-

picted on the concavity of the kathode cup. How are they formed? From whence came they? Of what composed?

Are there separate and distinct rays emitted from the tube, some of which cause burning, other fluorescence, and still others photographic effects; or do the same rays produce all of these phenomena? What rays possess the healing power?

Where and how does the x-ray have its birth? Of what does it actually consist?

(1) In the old form of Crookes tube, without a target, the x-light is generated in the glass wall of the tube wherever it is subjected to bombardment, and at the place of bombardment heat and a green fluorescence always accompanies the generation of the x-light; and in the form of tube now employed the portion of the kathode stream passes by the target; or if the target is displaced the entire stream passes by and generates x-light likewise by the bombardment of the glass wall of the positive end of the tube, accompanied by the green fluorescence (which on account of its position and shape I have christened the aurora borealis of the x-ray tube) and the usual modicum of heat; then does it not follow that wherever there is a green fluorescence of the glass wall of the tube, with the production of heat, there the x-rays are always generated, and the glass surface is the seat of molecular bombardment?

(2) If the rays of Roentgen have their birth at the target, why do they not shine thru that structure as they do thru the glass wall that is subjected to bombardment? Can the target reflect rays that

*Read in part verbatim, in part by outline, at the meeting of The American Roentgen Ray Society, held at the University of Pennsylvania, Dec. 9-10, 1903.

are not reflectable, and not subject to refraction or diffraction?

(3) Why are the afferent target rays convergent, the efferent target rays divergent (leaving out of consideration the effects of their respective construction), unless the former partake of the character of the negative, the latter of the positive, electrical brush discharge?

(4) If there is not an anodal stream, how shall we account for the bluish marking of the glass wall of the active hemisphere, which is proportionate to the amount of service a given tube has seen?

(5) If the x-light is not generated in the glass wall, why does its volume increase with the size of the tube employed, and consequently with the extent of the glass surface exposed to the anodal influence, while the size of the target is relatively unimportant?

(6) If the x-light is generated both at the target and in the glass wall, would not the photographic plate show a double picture?

(7) If it is the x-ray that causes the glass wall of the tube to fluoresce with a green color, why does it not cause the same phenomenon in a piece of glass held in any portion of the x-ray field?

Are infinitesimal particles of glass or other forms of matter projected from the tube into the x-ray field? (Nicola Tesla was one of the first to advance the hypothesis that matter was thrown from the tube outward into space.) If not, why is the x-ray inflammation of the skin nearly always upon the side of the parts presented toward the apparatus? Why does the clothing or a thin aluminum screen afford so much protection to the bodies of operators and patients? The dermatitis may end abruptly where the clothing has covered the person.

Is there some unknown radio-active element like radium, polonium, thorium,

uranium and helium in the glass wall of the tube, a hypothetical roentgenium, if you please, which, when subjected to bombardment, emits radiant energy or radiant matter?

(1) If this is not the case, why should a new tube fluoresce with a bright grass-green color, become duller, more like an olive green, then yellowish and paler with months and years of use?

(2) Or why should the radio-activity of an adjustable vacuum tube gradually decrease after a year or more of service, altho the target glows with the usual amount of redness?

(3) How shall we account for the bluish, greenish and yellowish tints (not pyro stains) sometimes seen in the developed negatives?

(4) Why does the new examining screen follow somewhat the same change of colors as the x-ray tube?

(5) Will the incorporation of radio-active elements in the glass wall of the tube multiply its present capacity and its therapeutic effects? If so, what a promising vista of future possibilities opens before the radiographer.

(3) Why should an eight-inch tube exhausted by use recover by rest much more rapidly than a smaller tube?

If he injudiciously ventures too near the excited tube, or remains in the

[*Additional notes taken at the Philadelphia meeting of the Roentgen Ray Society. Dr. James P. Marsh, of Troy, N. Y., reported that the soles of his feet had been burned. Their position was under the operating table, the Doctor sitting near the patient. As a result of the condition of his feet the Doctor was obliged to be carried about by attendants. It was explained at this meeting that the dermatitis probably came from the reflected rays.]

weaker zones of the field, too many days, months, perhaps years, and if in consequence he sustains x-ray inflammatory effects, with their complications and sequelæ, he is liable to ejaculate, How infernal! for beautiful, marvelous, profound and infernal are the attributes of the x-ray tube.

It is with the last subdivision, the untoward effect of the x-ray upon the operator, with which the present paper is principally concerned.

X-RAY INFLAMMATION.

This danger to the operator increases with:

- (1) Nearness to the tube (in a compound multiple ratio).

- (2) Number, frequency and duration of exposures.

- (3) Size, hardness and degree of excitement of tube.

- (4) Poor bodily condition.

- (5) An injury, blow or cut on parts slightly affected.

- (6) Number of previous attacks, each attack leaving him more vulnerable.

Conversely, the danger decreases with:

- (1) Distance from tube.

- (2) Infrequent and short exposures.

- (3) Softness of tube, provided it is under-excited.

- (4) Interposition of substances, clothing, screens of copper plate, iron, tin, zinc, aluminum, plate glass, etc., their density, thickness and other qualities as yet unknown.

- (5) Vigorous bodily condition.

- (6) A position behind the target and static machine, from whence rheostat and spark gaps can be operated.

The danger varies with the different types of tubes, and we may judge by the appearance of a tube the degree of penetration of its rays without the employment of the fluoroscope.

All other conditions being equal, a hard tube is one in which the free concave surface of the kathode cup has a light blue, transparent, circular spot, about the size of a silver dime, with a prismatic ring of colors at the outer border of the blue. The target glows with a redness thruout its entire extent with a reddish white center. The glass wall of the active hemisphere, covered with a translucent blue deposit, is the most dangerous; its rays are most penetrating.

A medium tube, one having a kathode cup colored with a dark blue central spot about the size of a five-cent silver piece, and having a target that glows with uniform redness, a blue cloud hovering behind the target, is less dangerous; its rays are less penetrating.

A low tube, one having a kathode cup colored seal brown, of a golden hue, or a minute, blue-black central spot with a red border to the blue, having a blue kathode stream and a green aurora borealis, i. e., positive or northern green circles at the positive end, the stem of the same extremity having a green color, is less dangerous, its rays being least penetrating.

The classification of tubes into hard, medium and soft, is very general, because in practice we are using tubes of every degree of each subdivision; but it will answer our present purpose if I make special mention of the extremely high and extremely dangerous tubes that are hard to excite; once started they light up irregularly accompanied with a crackling sound, they have small dancing green spots, formed by the splashing of a portion of the kathode stream against the wall, they also have a green aurora australis.

(To Be Continued.)

X-Ray Burns.*

BY ROBERT S. GREGG, M. D., CHICAGO.

It is well known that the x-rays produce what is known to the laity as a burn, but technically is a pure and simple dermatitis. This effect I attribute to its chemical properties. Time must elapse, from a few hours to a few days, before the characteristic symptoms arise. The reaction in some individuals arises much quicker than in others. It may be noted that after the patient has had this condition, and upon healing of the same, pigmentation is induced, probably due to the greater blood supply and extravasation in the parts, and it has been my observation that a patient will not reburn as readily with the same amount of treatment as he did at first, due probably to the extra resistance of the skin from the pigmentation caused by the chemic properties of the x-ray, which may be termed partial immunity. If the treatment be excessive, decomposition takes place beyond the power of the tissue to re-establish an equilibrium; in other words, the anabolic process of the tissue does not meet the katabolic process which has been accelerated by x-rays, and a consequent destruction takes place. The sloughing condition at times noticed is due to a high degree of katabolism. How are we to prevent or overcome this condition? First, a proper knowledge of the action of the tube is essential. Second, we should endeavor to know the susceptibility of each and every case. Here a knowledge as to the constitutional condition of the patient is a great aid. A lessened vitality on part of the tissues and the body as a whole predisposes to a much quicker decomposition, with a lessened reaction to the same. Idiosyncrasies are not to

be considered. Healthy tissue resists the action much more strongly and longer than diseased, owing to its greater anabolic or assimilative power. On this account it is perfectly safe for the x-ray worker to expose healthy tissue in the adjacent area, knowing that he first observes reaction in the diseased area, and with close watching can stop short of destruction of healthy tissue. The factors that enter into the production of an x-ray burn are as follows: Actinic or chemic rays, katabolism, anabolism, resistance, vitality, susceptibility and pigmentation.

I think it might be well here to speak of the results produced by different light treatments as a whole, and draw therefrom some comparisons as regards the cause of their efficiency and destructiveness. I think we will find that heat is the factor paramount as regards the results produced in certain forms of light treatment, and the actinic properties the therapeutic and destructive agent in other forms, namely in the x-ray. We know that if light is concentrated a greater production of heat accrues, which is due to concentration and the resistance of the medium. The beneficial effects constitutionally are co-existent with the amount of sweat produced, which is the desired aim where heat is the paramount factor. The flushing of the capillaries of the skin with blood, and maintaining the same for a time, depletes deep congestion. We are aware that a red medium will absorb everything but the heat rays, a blue medium everything but actinic rays. The sun produces what is known as a sun burn, but technically is an erythema in the true sense. It is not a burn, because it occurs several hours after exposure and produces a pigmen-

*Read at the first annual meeting of the American Electro-Medical Society, at Chicago, Dec. 1-2, 1903.

tion of skin similar to that of the x-rays, so that it must be due to the chemic or actinic rays. This erythema, whether from sun or x-rays, is followed by pigmentation, which offers great resistance to actinic rays, so that exposure over the same area has to be increased in order to produce the same results. Chemic rays are a powerful stimulant to metabolic processes. We find in the negro a person unsusceptible to the chemic rays of the sun; in other words, an erythema (sun burn, so-called) does not take place, due to the large amount of pigment already in the skin. We also note that while, as above stated metabolic processes are remarkably increased, it does not appear to affect the red blood corpuscles any more than probably to cause them to absorb the chemic or actinic rays, and in turn give them off again. On the white corpuscles it seems to produce a leucocytosis, which we know is nature's bulwark for defense against disease. It has been demonstrated that silver chlorid injected under the skin will turn black when subjected to chemic rays, proving conclusively their activity within the tissues.

The treatment for a burn is first and foremost to omit intense raying, then increase visceral elimination and treat locally; in fact, meet the conditions as they arise. Some experts report much more rapid recovery under very mild raying than when raying is omitted. Absorption is taking place so that elimination is absolutely necessary. An x-ray burn requires a long time to heal, as a rule, due

to the lessened vitality of the tissue cells, so that the patient must be built up constitutionally. Visceral drainage is paramount as an adjunct to treatment by x-rays; and all patients, no matter what the condition, must be drained. Half normal salt solution is to be given, a glassful every two hours, for six doses daily, to act on the bowels and kidneys. Associated with this a mild laxative sufficient to produce a daily stool is probably the best method.

Much has been said regarding the necessity or advisability of producing a dermatitis or x-ray burn in order to aid a cure. I hardly think it advisable, especially in an ulcerated area, because a very rapid metastasis invades the adjacent inflamed area, particularly when the burn is very severe. Hence the disease spreads, and instead of being cured the patient's condition is worse, and he usually dies of sepsis. Not only is this true of metastasis, following an extreme dermatitis of an ulcerating area, but in conditions of cancer, which retrogrades under certain modes or technic of treatment; and particularly when ulcerating areas are exposed to the x-rays without properly protecting the parts against dust particles which are thrown off from the surface of the tube. This is often the cause of secondary infection. While under treatment of x-rays it is essential that the parts be properly protected by borated gauze, or some other antiseptic protective agent.



Galvanic Electrolysis as a Cure for Stricture of the Urethra.*

BY J. C. LUKE, M. D., OCILLA, GA.

In the treatment of urethral stricture we have in the galvanic battery a safe and certain cure, if properly used. It is a well known fact that at the positive pole of a galvanic battery we have an acid reaction and if applied to a mucous membrane it has a contractile action. At the negative pole we have an alkaline reaction, and if applied to the mucous membrane we have a dilating effect: So in treating stricture we should never use the positive pole, but always the negative, in the urethra. My plan is the same as was used by the lamented Dr. Robert Newman, only I possibly make the treatment a little more frequent than he did. He gave a treatment about once every week or ten days. If I have a very severe case I treat my patient from every other day to every fourth day, and get the same results in a good deal less time.

My plan is simply to watch my patient closely and if I set up sufficient irritation to cause him much pain on micturition I leave off all treatment until he is in good shape again. I then continue my treatments as before until I get the urethra so that I can pass the proper-sized sound. I here cease to use galvanism, teach him how to pass the sound, and leave him a sound with instructions to pass it at least once a week for five or six months. So far I have had no trouble in the cure of urethral stricture.

The current used in treating stricture should never exceed 10 milliamperes, and from 3 to 6 is what I would deem safe, as with that current you seldom set up sufficient irritation to cause any trouble or even stop the patient from work. The following case will show the results in my hands:

CASE No. 3. W. B., white man, age 38 years, railroad engineer; 16 years ago had gonorrhea, which was treated and cured by his physician with the usual astringent injections, after which he married and has raised a family of five children. Some three years ago he noticed he was troubled some with his bladder, and after passing water there would be a dribbling. This trouble kept growing gradually worse until he consulted his family physician, who told him that he had some slight bladder trouble, prescribed for him and gave him some relief. But he noticed that the stream was small and sometimes hard to start, and his condition gradually grew worse until he got to where he "wet on his feet," and he then consulted me in June of this year. I put him on my table and tried to pass a No. 10 sound, but without success. I then took small filiform and with difficulty succeeded in passing it thru into the bladder. I then passed a No. 10 copper electrode down to the stricture and turned on a current of six milliamperes for three minutes (I had the positive electrode placed on abdomen, with negative to urethral sound), but failed to pass it. I had him then go home, with instructions to come back on the second day. He was on hand promptly and I used the same sound to start with, and with the same current in about one minute's time I had passed thru the first stricture, which was about two and a half inches from the meatus. I found, on passing the electrode on down, that about one inch from the first there was a second stricture thru which the electrode passed in about two minutes, after which I could pass it on to the prostate gland. At this treatment I kept passing different

* Read before the American Electro-Medical Society at its First Annual Meeting at Chicago, Dec. 1, 2, 1903.

electrodes until I could pass size 16. I then stopped and told him to come to the office on the third day. But that evening he had a severe chill and high fever which was overcome by large doses of quinine. He called at my office on the fourth day. I began with electrode size 14 and passed them with the negative current six milliamperes until I reached size 20. I gave him quinine after his treatment so as to keep off a chill, and had him call again on the third day, which he did. I then passed from size 20 up to 24, and the third day from then passed up to size 28, and then put him to using steel sounds. Up to this time he has had no trouble. He noticed from the first treatment that he could

pass his urine more freely, and now passes it like he did when a boy, he says. He never had any trouble at all from the treatments, except the one urethral chill, and he says that now he is perfectly well, so far as he can tell.

I have a number of cases that I have cured in like manner, but this case will illustrate the plan of treatment, and I feel safe in saying that any case of organic urethral stricture can be cured if this plan is properly carried out.

It is best never to use any force in trying to pass the electrode thru the stricture, as the action of the current will dilate it sufficiently, and there is no danger of setting up any severe irritation if no force is used.

Electro Physics.

New Source of X-Rays.

The editor of the *Medical Herald* for November thus relieves his mind regarding radium:

"The discovery of the rays as well as the means used for its production assume a very different plane, however, when we consider the substance radium, the work of the Master Builder, a substance so perfect in its construction, so complete in its action and so wonderful in its working as to make us feel that our most finished machinery is crudeness itself, and our work of the most bungling character when compared with the work of Him who spake to the light and it was."

The Electrophone.

According to *Electricity*, the electrophone is rapidly coming into favor among reporters. The reporter by this means may do his work in a distant office, away from the disturbances of a public audience, where every word is heard distinctly over the wire.

Heating Effects of Radium Emanation.

To settle the question whether the heat emitted by radium is directly connected with the radioactivity of that element, or independent of it, Messrs. E. Rutherford and H. T. Barnes have carried out the following experiments. The heating effects of thirty milligrams of pure radium bromid was first measured in a differential calorimeter. The radium bromid was then heated to a sufficient temperature to drive off the emanation, which was condensed by passing through a short glass tube immersed in liquid air, and then the tubes were sealed off. In testing the emanated radium, the heating effect diminished rapidly during the first few hours; fell to a minimum corresponding to about 30 per cent of the original value, and then slowly increased again. On substituting the emanation tube in the calorimeter, the heating effect first increased for a few hours to a maximum corresponding to about 70 per cent of the original heat emanation of the radium, and

then slowly decayed with time. At any time after removal of the emanation, the sum of the heating effect of the de-emanated radium and of the emanation was found to be the same as that of the original radium. There is an exact parallel between the variation in radiating power, measured by the α rays, and the heating effect. It is thus seen that the heating effect of radium directly accompanies the α radiation from it, and is always proportional to it; and that more than two-thirds of the heating effect is not due to the radium at all, but to the radioactive emanation which it produces from itself. This result accounts for the variation of heat emission with age, observed by the Curies. The amount of emanation from thirty milligrams of radium bromid was sufficient to cause a bright phosphorescence in the tube, but it was too small either to measure or to weigh. The amount of heat emitted from the radium emanation is thus enormous, compared with the amount of matter involved. The results are explained on the disintegration hypothesis, in which the heat is considered to be derived from the internal energy of the atom. If, however, as held by some, radium gains its heat from an external source, it would be necessary to suppose that less than one-third of the heat is due to the radium itself, and that the other two-thirds are due to the radium emanation which is being continually produced, and the power of which of absorbing from an external source decays with time.—*Abstracted from Nature (London), by El. Review.*

Electricity in Dental Extraction.

From a paper read before an eastern dental society we note that the writer states that electricity is taking the place of gas and ether rapidly in dental extractions. The current, he quotes, is

that of high frequency and is applied to the lower jaw, where the operator desires to render it insensible by means of a heat apparatus. The patient, it is claimed, feels nothing more than a slight heating of the affected parts. In our opinion, this method is much safer than cocaine and other anesthetics, that are so largely used by the profession.—*Medical Educator.*

Roentgen Ray Tanning.

It is stated from Cincinnati that experimenting has resulted in the discovery of a process of tanning, by means of which hides can be transformed into leather in a short time by the use of the x-ray. The hides will be soaked in lime for the separation of the fibers and removal of the hair, as is done now. When this has been completed, which usually requires about four days, the hides will be soaked in a solution of certain chemicals, a part of the invention, for about two hours, and will then be exposed to the x-rays for about fifteen or twenty minutes, which will thoroly tan them. The finishing will then proceed in the way employed at present. Under the new system the chemicals absorbed by the hides during the two hours' soaking are said to be decomposed by the x-ray in less than half an hour. After the hides have been soaked in the solution they are put on a highly polished steel plate and a series of three tubes diffuse the rays upon their entire surface. They remain in this state for about twenty minutes, when they are ready to finish as usual into enamel, patent leather or any desired article. The great difficulty which the inventors met was to obtain a ray sufficiently strong to penetrate the entire hide. Now, twenty hides, one on top of the other, can be "rayed" at once. The inventor asserts that not only will this new process reduce the time necessary for

tanning from four months to four days, but it will also reduce the cost of manufacture fully 75 per cent. As if this advantage were not sufficient, it is added that the costs of fitting up a plant necessary for the working of the process is only one-fourth the cost of erecting a plant under the present system.

Power of Radium.

Mr. Edward D. Adams, of New York, has presented to the New York Natural History Museum a tube of radium of 300,000 power. This was secured thru Dr. George F. Kunz, the gem expert of Tiffany's where, as well as at the Museum, some most interesting experiments have been made on precious stones and crystals, including the new Kunzite. Working in experiments together, Dr. Kunz and Dr. Charles Baskerville, of the University of North Carolina, believe they have made a valuable discovery in connection with willemite. By mixing radium with natural willemite, pulverized to a powder, the activity or power of the former

substance is multiplied a hundred-fold, and probably—for no instrument has been devised for measuring the increase of the activity—a thousandfold. That, at least, is the temporary effect of the mixing of the two substances. Time must tell whether one will nullify the other. Willemite is a comparatively cheap silicate of zinc. It is possible, also, that there is in willemite a substance which is as yet unrecognized as a distinct element, but which produces the radioactivity that has awakened the enthusiasm of the two experimenters. But thus far it is taken for granted that the one substance merely stimulates the activity of the other. The germ of a very valuable discovery seems to lie here. Mr. Adams has now supplemented his previous generosity by authorizing Dr. Kunz to secure some radium of not less than 1,800,000 activity, which will probably be placed at the disposal of some of the hospital authorities for experiments on the alleviation or cure of disease.—*El. World and Eng.*

Radio Therapy.

Cancer Cured by Radium.

At a recent meeting of the Vienna Academy of Medicine Professor Gussenbauer read a paper giving details of a case of cancer of the hard palate which was cured by means of radium rays. The patient, a man past sixty years of age, had been repeatedly operated on without success, the disease recurring and rendering necessary further and more extensive operations each time. After the last operation, which occurred last fall, it was decided that nothing further should be undertaken. At this time the individual was exposed to the radium rays, and a gradual and complete disappearance of the growth took place which up to the

present time has not returned.—*Medical Age.*

What Can Be Done For Cancer?

Dr. Emory Lamphear (*Amer. Jour. Surg. and Gyn.*, November) says cancer is a purely local disease at its beginning and all cancers may be cured by early incision. England with her thirty-five millions has an annual loss of 30,000 lives from cancer. Various methods of treatment are discussed briefly, namely:

1. Excision by a cutting operation (knife or curet).
2. Removal by actual cautery.
3. Destruction by pastes (arsenical, etc.).

4. Endermatic introduction of destructive fluids into or around the morbid growth.

5. Use of x-ray.

6. Finsen light.

7. Solar cautery.

"Each of these has its advantages and disadvantages under certain conditions; each, perhaps a special adaptability to peculiar circumstances. Common sense as well as surgical judgment must be exercised in the selection of the particular kind to be employed in each individual case."

Special directions are given for the treatment of cancer of the face, tongue, larynx, breast, rectum, uterus, etc.

Cancer Following X-ray Burns.

Apropos of the reports from America of the injuries to Mr. Edison and assistant in the use of the x-rays, we are again reminded of the unfortunate death of Mr. Blacker, whose widow has just been granted a pension of £120 by the British government. This is a tardy recognition of Dr. Blacker's treatment of the king for rodent ulcer. His majesty recovered, but Dr. Blacker died, not, perhaps, from the direct effect of the rays employed in treating the royal extremities, but rather to his devotion in treating a large number of cases connected with the hospital. There are now a considerable number of cases on record of cancer developing at the site of x-ray burns. It is curious that the most of these cases were epithelial growths, the kind of cancer in which the x-rays are especially valuable.—*Medicine*.

X-Ray and Light Research.—At the last session of the legislature \$25,000 was appropriated to the University of Pennsylvania for a laboratory for x-ray research and for Finsen light apparatus. The department will be connected with

the University Hospital. It is planned to build a laboratory in connection with the Agnew pavilion. Dr. Henry K. Pancoast, assistant instructor in clinical surgery, and assistant demonstrator of surgery, will have charge of the department. It is the purpose to establish a very complete Finsen light plant, with the prospect of undertaking the first extensive experiments conducted in this country by this method in the treatment of diseases of the skin.—*Jour. A. M. A.*

Radiotherapy in the Treatment of Ozena.—Adolphe Casassa says that four species of bacilli have been described as specific to ozena, but so far treatment by antiseptics and by serum therapy has proved valueless. Professor Dionisio has reported the result obtained in six cases by the use of the x-ray. There was rapid diminution in the secretion and crusts, and prompt disappearance of the characteristic odor, even in cases that had proved rebellious to all other treatment. More recent reports have brought the number of cases improved up to twenty. The author in his own experiments obtained such excellent results that he can only conclude that radiotherapy is the first and only rational treatment for this offensive and troublesome disease.—*Revue Internationale de Thérapie Physique*, October 1, 1903.

Legal Status of the X-Ray.

Hon. W. W. Goodrich at the meeting of the Medical Association of New York State delivered an address upon this subject. Decisions of the supreme court of Colorado and Tennessee place x-ray photographs upon the same basis as ordinary photographs of the surface. The photographs must be verified by an expert of known qualifications. With regard to x-ray burns the same rule holds as in

other cases. The physician is bound to treat his patient with the same skill as is usual in the time and place where the treatment takes place.

Radio-Therapy.

Dr. C. D. Center, Quincy, Ill. (*Int. Journal of Surgery*, October, 1903), reports a number of cases treated by x-rays in his practice, including lupus, epithelioma, carcinoma, sarcoma, psoriasis, eczema, hypertrichosis, sycosis, nevus, lichen planus, pruritus, keratosis, acne and keloid, with varied success. In one case of hypertrichosis the hair recurred more luxuriantly than before. Two cases of keloid were practically cured. In several cases of carcinoma autointoxication developed and a fatal termination was probably hastened by the treatment.

X-Ray, Light and High Frequency Currents.

Dr. B. H. Boggs, New York City, at a meeting of the Medical Society of Pennsylvania, September 23, 1903, said that the x-ray does not cause metastases in carcinoma but rather prevents them. Of twenty-eight cases of pulmonary tuberculosis, two were apparently cured. Of five cases of tubercular growths three were cured; of twenty cases of lupus all but two (which were probably syphilitic) responded to x-rays. Caution is necessary in

deep tumors lest a septic condition may be caused by absorption of broken down material.

Future of the Roentgen Rays.

In *The American Practitioner and News* (October, 1903) Dr. Waltham has an editorial on this subject. He considers the x-rays to be of real value only in diseases that are comparatively superficial, and that we can expect little improvement in such deep seated diseases as cancer of the stomach. The most suitable cases for x-ray treatment are epithelioma of the skin, enlarged glands both tubercular and Hodgkin's, certain types of eczema, superfluous hairs, and many other superficial lesions. Diseases of the liver, stomach and uterus, and tuberculosis of the lungs and bones, are not suitable for the rays.

While it is well to be conservative there is just as much danger in being too conservative as in being too radical. It seems to us that with the improvements in technic which are being rapidly effected, and with the encouraging results reported in cases in which the technic has been properly looked after, we have every reason to expect that diseases of the stomach, intestines, lungs, liver and bones will be nearly as amenable to x-ray treatment as those that are nearer the surface.

Photo Therapy.

Finsen Light.

Dr. R. H. Stevens, Detroit (*N. Amer. Jour. Homeopathy*, October, 1903), describes the Finsen ray apparatus, calling attention to the fact that Finsen depends upon the intensity of the light and not simply upon the ultra violet rays. The ultra violet rays are the most bactericidal but have also the least power of penetration. Dr. Reyn, one of Finsen's assistants, has perfected a similar and

cheaper apparatus for treating one patient at a time. This lamp requires twenty amperes, and is placed much nearer the patient so that it is just as effective as the larger lamp. The light from it will kill bacillus prodigiosus in less than a second. Dr. Stevens quotes from Finsen's report on 840 cases of lupus of which 695 were greatly benefited if not entirely cured. In lupus erythematosus out of forty-four cases fourteen have been cured.

Epithelioma cutaneum, twenty-four cases, eleven cured. Acne vulgaris, twenty-five cases, eleven cured. Later results in similar cases have been even more successful.

Violet Rays in Treatment of Tuberculosis.

Dr. J. Mount Bleyer, New York (*Medical Brief*, November, 1903), finds that violet rays from the electric arc rank as one of the greatest tonics in bacterial diseases. Of sixty cases of tuberculosis he reports forty cured and the disease arrested in the other twenty. This treatment must not be given homeopathically. Exposures must be not less than half an hour over the selected area. Good carbons are very important. Along with this treatment hygienic food, fresh air, exercise and such remedies as are indicated will cure 75 per cent of tuberculous patients; the cure being partial or complete, according to the pathological condition then present. He prefers concentrated sunlight where this can be obtained. The arc lamps should have no lenses whatever, as glass is nearly opaque to ultra violet rays.

The Solar Cautey.

Dr. O. V. Thayer, in the *Pacific Medical Journal* for September, contrasts other methods of treatment for malignant growths with his solar cautey. He states that during the last thirty years he operated more than 2,000 times with concentrated sunlight and has yet to find any case of injury from it. "Unlike other caustics and cauteries, it can be applied to delicate membrane or tissue; and inflammation following its application is surprisingly slight and of short duration. The pain subsides immediately upon removal of the lens. Blistering is avoided, as the burning is carried beyond that point. The abnormal tissues are carbonized. In the treatment of all morbid growths these must be fully destroyed.

Upon this depends the success of the operation. The tissue must be thoroly desiccated before cremation takes place. If the solar heat is applied for more than a few minutes at a time the fat in the tissue is melted and effusion of serum is increased, preventing further destruction. After waiting for a short time for the part to cool the application is renewed, and continued from time to time until the job is accomplished. The part is then dressed so as to thoroly protect it from the air. In three or four days carbonized material is thrown off leaving a healthy sore, which is treated as any ordinary wound. The resulting cicatrix is very slight." He claims that there is very little pain, less treatments are required, there is less constitutional disturbance and greater probability of cure than by other methods.

Effect of Light and Heat Rays on the Temperature of the Skin.—An interesting series of observations have been in a series of about one thousand cases with the aid of Herz's apparatus, by E. Sommer (*Berl. klin. Woch.*, October 5, 1903). This apparatus is essentially a differential air thermometer, furnished with an alcohol manometer. Incandescent electric lights in blue, red, yellow and green globes were employed, the lamp being held about 10 cm. from the skin for a period of ten minutes. It was found that the skin over chronically inflamed joints was lower than on the healthy side, unless an acute exacerbation of the process was present, in which case the relations were reversed. Under the influence of warmth and light radiation the temperature of the side treated always rose above that of the other side; but there were certain cases noted in which the temperature after exposure to the rays was less on both sides than before. Radiation of this type does not produce a reaction in the sense of a cooling, with

the same regularity as results from the application of heat and cold by other methods. The effects of the rays with a short wave length are of longer duration than those with long wave lengths. After two or three hours the relations change, the side exposed seems colder than the other, a condition which is apparently due to the reactionary rise on the side which was not exposed.—*Medical News.*

Prof. R. W. Wood, of the Johns Hopkins University, has discovered that nitroso-dimethylanilin, when combined with cobalt glass, furnishes a screen which allows only ultra-violet rays to pass thru.

A Lightning Conductor.—An interesting episode is thus noted by the *St. Louis Globe Democrat*: "Some kind of a memorial should be presented to the engineer of the cogwheel railroad on Pike's Peak. Being struck by lightning and stripped of his clothing, he calmly attired himself in a Navajo blanket and continued his duties. We must ever feel an unquenchable admiration for such sprightly unconcern. It is quite customary when struck by lightning to make a great fuss about it; to demand the services of everybody in the neighborhood for our resuscitation and to bring the business we may have had in hand to a dead standstill."

Electro Therapy.

Electricity in General Practice.

Dr. W. B. Neftel, New York, in *The Medical Record*, November 28, gives a brief summary of the development of electrotherapy and describes a number of cases in which electric treatment has been of the highest value in his practice. He speaks also of the very great value of the electro diagnosis in many otherwise obscure cases. He uses merely the galvanic current and the faradic machine, two of the simplest forms of apparatus which are easily made use of by any physician, and gives in detail his method of treating the motor nerves, brain, sympathetic nerve, pneumogastric nerve, spinal cord, and neuralgic and other conditions.

"The costly, complicated apparatus should be left to the specialist, neuro-pathologist and electro therapist for therapeutic purposes and scientific researches."

Treatment of Pulmonary Tuberculosis With High-Frequency Currents and Intralaryngeal Injections of Antiseptics.

High-frequency, low-potential alternating currents have been used by Dr. J. Cunningham Bowie for treating pulmonary tuberculosis, with some degree of success. He found that the passage of a current of electricity thru toxins considerably modified and annulled their toxicity, and that the greater the volume of electricity used the more quickly this was accomplished. He concluded that electricity might be of value in the treatment of phthisis or other diseases where bacterial toxins had to be contended with. For this purpose an apparatus which would develop a fairly large current at a high frequency was necessary, and this apparatus should make it possible to regulate the frequency, the voltage and the current at will. An apparatus of this kind

was constructed and has been used in a number of cases, the results of which he gives. Almond oil, containing iodine, thymol and other antiseptics, was used for intralaryngeal injection. The current density varied from 300 to 800 milliamperes; the voltage from fifty to seventy, and the time of application from ten to twenty minutes. The arrest of lesion was brought about by this treatment more quickly than by the use of antiseptic oils alone, and the author's experience shows that the high-frequency current promotes healing.—*Abstracted from the Lancet (London), October 31, by Electr. Rev.*

Some Principles on which is Based the Therapeutics of Electricity in Nervous Diseases.

—A. D. Rockwell believes that the reasons why so many physicians are disappointed in the results of electrical treatment are: (1) Ignorance of the physics and physiology of the method employed. (2) Imperfect technique. (3) Failure to appreciate the differential indications for the use of the various modalities. He then discusses the conditions presented by various common maladies so far as indications for the employment of electricity are concerned. Concerning true neuralgia, he notes that pressure invariably increases the pain, while in pseudo-neuralgia it often affords relief. In these cases the local application of the cathode is to be preferred to that of the anode. Not only this, but the faradic current itself is peculiarly effective in such cases, and will give relief when the galvanic utterly fails.—*N. Y. Med. Jour.*

Heat Radiation of Incandescent Lamps.

Fischer (*Zeit. f. Beleucht.*, July 13, 20) gives the results of a scientific investigation, in order to ascertain how much of the energy of the current appears in the

form of heat and of light in the ordinary incandescent lights. For these experiments he used an incandescent lamp of 110 volts, having resistance, when cold of 300 ohms. The heat energy was measured by a thermopile, and the light energy by a prism-photometer. Several tables of results are given, showing that by far the major part of the electrical energy is converted into heat. With a current of .317 amp. the author finds 99.82 per cent appearing as heat and only .74 per cent as light, the latter gradually rising to 26.5 per cent when the current had increased to .718 amp.; the lamp was then giving about 32 cp. Under the normal conditions of the 16-cp. lamp, the author found 85 per cent as heat and 15 per cent as light, with a current intensity of .621 amp.—*El. World and Eng.*

A Method of Reversing Influence Machines.

When desirable to reverse the polarity of an influence machine, the usual method of procedure is to ground both terminals, give the machine a few turns in the opposite direction, then remove the grounds and start the machine normally. The effect of this operation is rather uncertain, and Herr J. R. Januszkiewicz has devised a system which is more reliable. In this one pole of the machine is connected electrically to the inducing plate for the opposite pole. The machine is then revolved in the normal direction, and if the connection then be broken, the polarity of the machine will be found to be reversed. If the machine is running at a fair speed, but a momentary connection is needed, while if it is running slowly, it may be necessary to leave the connection for ten or fifteen seconds. Care should be taken that good electrical contact be made.—*Translated and abstracted from the Physikalische Zeitschrift (Liepsic), October 15 for Electr. Rev.*

A Study of Light.—Ultra Violet Light.*

BY J. MOUNT BLEYER, M. D., F. R. A., M. S., LL. D., OF NEW YORK CITY.

Wonderful as the nineteenth century has been in all that pertains to the development of science, the twentieth century promises in one respect at least, to surpass it. The nineteenth century may be regarded as the triumphant period of the medical philosopher, the Alexander of modern times, who has so little matter left to conquer. The twentieth century will be the apotheosis, so to speak, of the progressive doctor and his scientific colleagues who engage in the investigation of medicine and its allies.

Long ago philosophers remarked that their knowledge of nature was limited by the number of senses, and would probably extend itself if these were increased or even perfected; nothing, indeed, authorizes us to believe that the properties of nature are limited to those which affect the senses of man.

An objection may be raised to the fact that if such waves of light as those now under consideration are invisible, they can not be waves of light. If you were to lay down as a definition beforehand that the term "light" must be applied only to the waves that are visible to the human eye, there is nothing more to be said. But let me say that science has given us other eyes, or other processes that will enable us to observe these invisible Ultra-Violet waves of light! It is found that these invisible waves agree with the visible waves in other important respects, that they can be reflected, refracted, polarized, and diffracted, and we are bound to notice them as light. They may have wave lengths that are longer than that of the red waves, or smaller

than that of the violet waves, and so our eyes, with their limited range of perception, fail to be sensitive to them; nevertheless, if in their physical properties they agree with the invisible kinds, then the fact that to us they are invisible simply demonstrates the natural shortcomings of our sense of sight.

It has been supposed that some animals may have the power of distinguishing such colors of light; that is, that their eyes are affected by those rays of high refrangibility which produce no impression of light upon the eyes of man. M. Biot has, it would appear, found that some such effect is produced by rays upon the eyes of some of the night-roving animals by rays invisible to us. This may be, that which is colorless to us when we come from the sunshine into it is found, after a little time, when the lenticular arrangement of the eye has been adjusted to the required condition, to produce the sensation of tolerable light. May we not, therefore, explain on the same principle the power which the cat, the owl, and other animals possess of seeing in the circumstances we might regard as darkness.

At the extreme end of the spectrum, beyond the violet, we have these waves which are called invisible by reason of being of too small a size to affect our eyes by direct vision—and these very ones interest us at present mostly on account of their special therapeutical value, and other physical properties that they possess. They are known to be active in producing certain chemical effects, notably the photo-chemical or photographic. They also produce certain physiological effects on animal and vegetable tissues, they actively provoke in certain

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bodies the property of shining in the dark, phosphorescence and fluorescence, and, lastly, they have certain electrical properties. These waves have earned for themselves the names of actinic, photographic, or ultra-violet.

Theoretically we know the extreme probability that rays in a beam of light will scatter if the beam passes thru a prism, and we find in practice that when a beam of sunlight is passed thru a prism the rays are so far scattered as to produce a spectrum very much wider than the original beam, and made up of a series of differently colored bands of light, of which the first is a red band, the next an orange one, the next a yellow, the next green, the next blue, the next indigo, and the last violet. Now we learn in regard to the spectrum, as Professor Stokes first showed, that when the spectrum is allowed to fall on certain substances, a band of colored rays, called the ultra-violet rays, becomes visible, beyond the violet band which is ordinarily seen; and also under similar circumstances a band of ultra-red rays is sometimes visible beyond the red band which is ordinarily seen. All kinds of light in the visible spectrum are comprised between the extreme red at one end, and the extreme violet at the other. Their wave lengths have been computed, and vary between about 32 millionths of an inch (extreme red), and 15 millionths of an inch (extreme violet). But besides these waves of various colors between those limits, which are visible, there are other waves that bring no sensation to our eyes, which are called invisible, and yet are light waves. We have found that the greatest luminosity to the eye is possessed by waves having a wave length of about 22 millionths of an inch or 0.00055 of a millimeter. The greatest heating effect occurs with waves of about 40 millionths

of an inch, or 0.001 of a millimeter. The greatest chemical¹ effect occurs with waves of about $16\frac{1}{2}$ millionths of an inch, or about 0.00041 of a millimeter.²

There are diversities of opinion regarding some of the physical, physiological and therapeutic behavior of the ultra-violet light. According to many experiments, it is found that the ultra-violet light is made visible to us in many hundreds of ways. Amongst the reliable ones, the spectroscopy and its photography tell us how long the extreme end of the ultra-violet extends in the spectrum. We also know that the ultra-violet exists in different degrees of intensity as we go up in the scale—or its spectrum.

Fluorescent materials of many kinds give proof of the presence of the ultra-violet light, when these substances are subjected to it. There comes up a great question before us, tho I am now of the belief, from my own study, that the invisible light most active in producing the highest degree of physiological, physical and therapeutic results begins at the blue end of the spectrum, and becomes more intense at the ultra-violet. How far up in the scale it extends is a question which is not yet solved. The ultra-violet seems to be the most active, possibly at a short distance or degree above the violet end, and thence becomes less and less as it still rises in its own scale higher up.

¹There is an assumption that the effect is measured by a particular chemical reaction, viz., the darkening of chlorid of silver, if a different reaction, say, for example, the darkening of ferro-prussiate salts ("blue print," which are much slower for giving a reaction) were taken as a basis of measurement, the maximum effects would be found to occur at some after point in the spectrum." Prof. Sylvanus Thompson, "Visible and Invisible Light," Macmillan Co. 1897.

²A table of wave lengths, and frequencies of all kinds of light from the lowest—ultra red, up to the highest, ultra violet—has been added here.

TABLE OF WAVE-LENGTHS AND FREQUENCIES.

Name of Line.	Color.	Wave-lengths in Micromillimeters. (Microns.)	Frequency, millions of millions, $\mu\mu$, per second.
(Rubens and Nichols' longest waves)		24000.	12.5
(Langley's longest waves)		15000.	20.
(Paschen's longest waves)		9450.	31.7
(Psi)	....	2700.	111.
(Phi) ₁	....	1240.	242.
(Phi) ₂	....	1200.	250.
Y	....	899.04	333.7
Y	....	898.65	334.0
X ₄	....	880.61	340.8
X ₃	....	866.14	346.2
X ₂	....	854.18	351.3
X ₁	....	849.7	353.3
Z	....	822.64	364.5
A	red	759.4	395.2
B	....	686.74	436.5
C	orange	656.30	457.2
D ₁	....	589.61	508.8
D ₂	yellow	589.02	509.1
D ₃	....	587.60	510.5
E ₁	{	527.05	569.2
E ₂	{	527.04	569.2
E ₃	green	526.97	569.3
b ₁	....	518.38	578.9
b ₂	....	517.29	580.0
b ₃	{	516.92	580.4
b ₄	{	516.91	580.4
b ₅	{	516.77	580.5
b ₆	{	516.75	580.5
F	blue	486.15	617.1
G	{ indigo	530.81	696.3
h	{	430.79	696.4
H	violet	410.18	731.3
K	....	396.86	756.0
L	....	393.38	762.7
M	{	382.06	785.1
N	{	372.78	804.6
O	{	372.71	804.9
P	....	358.13	837.7
Q	....	344.11	871.8
R	{	336.13	892.6
r	{	328.69	912.6
S ₁	{	318.14	942.9
S ₂	{	317.94	943.5
s	....	314.46	954.1
T	{	310.08	967.4
t	{	310.04	967.6
U	....	310.01	967.7
U	....	304.77	984.5
U	{	302.12	993.0
U	{	302.07	993.3
U	....	299.45	1002.0
U	....	294.80	1017.6
(Miller's limit, photo- graphic)		202.	1485.1
(Stokes' limit, fluorescent)		185.	1621.6
(Schumann's highest fre- quency)		100.	3000.

These tables are taken, with slight modification, from a lecture on "Invisible Rays" by Sylvanus P. Thompson, D. Sc., F. R. S., M. R. S., London. *Light Visible and Invisible*. The Macmillan Company, 1897.

I want to make reference on this point to the recent researches of Professor Marshall Ward on the action of light upon bacteria and fungi. The outcome of the research showed that the bactericidal power was at its maximum in the blue-violet region and extended for an unknown distance into the ultra-violet. This observation is of great importance in connection with the application of light to therapeutics. I agree with these researches from my own observations.

We have the same example, and many experiments bear us out, to a short distance into the ultra-red, then, after that, we have less and less use for it as a therapeutic agent. In other domains of science both these extreme rays have their significance and experimental uses.

We should take these facts, now, as far as our knowledge of the subject allows us, as a safe basis to go on in our therapeutical application of these rays, until the future holds out a more positive experimental proof of the therapeutic efficacy of those still higher refrangible rays.

I have no doubt that I shall find some who will differ from me on these points, but from the many experiments that are already recorded I have come to these conclusions. In the papers to follow, I propose to cite from the various noted physical experimentalists their own accounts on the ultra-violet light, in order to help me to convince those who have doubts from a number of directions as to certain known laws which the ultra-violet rays should obey. My own experiments will follow, giving some important new discoveries on these ultra-violet rays. By following out this plan of collecting together the most important facts known to

others, and adding them to my own, the reader will be able to judge and comprehend the many valuable points ready to be intelligently applied in the practice of medicine.

Another question which confronts us is this: How to establish the true therapeutical and physiological effects by combining the different rays of the spectrum into one, or in their separated and isolated state from the infra-red state to the ultra-violet, or even more refrangible state?

This is a ripe hour to call the attention to the experimental therapist and physiologist. Also we must not forget that dosage of any of the isolated lights of the spectrum will require some thought, each one of them separately, as well as the combination of all of them together in a mixed state. The quality and quantity of the different rays must also receive careful consideration. From what I have learned by experiments, I am well satisfied that these are some of the salient points requiring further careful experimenting. These questions are the coming themes for solution, if we wish to apply light intelligently.

If we desire for experimental purposes to separate the waves which can produce one of these effects from those which produce another, there are several courses open to us. Let us begin to sift out the ultra-violet waves from all other kinds—our method begins by the use of prisms which will disperse the waves, and sort them out into a spectrum according to their sizes. We may also accomplish the same thing by making use of a diffraction grating to produce a spectrum; also we may employ as a means of sifting sheets of different substances that have the power of absorbing waves of one sort, while transmitting those of another. This method was found a good way when applied to visible rays, for by using a red

colored glass it was possible to cut off all the other colors, and leave only the red. It is much to be regretted that no perfect filter screen exists that will cut off all the visible rays, yet allow the passage of the ultra-violet waves. I have found that glass which is tinted a deep violet color with manganese, or with manganese and cobalt, serves very well to cut off most the visible light, while transmitting a fair proportion of the ultra-violet waves, mixed with some violet light.^a The fact has been long known to me, and my experiments were satisfactory on that point, and found that blue glass for many purposes is good enough. "It is said, unfortunately, that every kind of glass cuts off the extreme part of the ultra-violet light; even the lightest crown glass, tho moderately transparent to waves of 15 millionths to 11 millionths of an inch long, is totally opaque to all waves smaller than 11 millionths, while dense flint glass (containing lead) is opaque to everything beyond the wave length of 13.3 millionths of an inch. Hence, for experiments on ultra-violet light, it is expedient not to use glass lenses or prisms, provided some more transparent medium can be found." Happily, both quartz and fluor-spar are much more transparent to ultra-violet waves than glass. Quartz transmits them down to 8 millionths of an inch, and fluor-spar down to 8 millionths."

This same stand is taken by most physicists, but it is not altogether correct. A vacuum tube of any given shape or size is exhausted by means of an exhaust pump to a point below a Geissler vacuum; and when a purple violet color is coming into view the tube should be sealed at that point of vacuum and removed. All my experiments (which are in the hundreds) showed that such a tube became capable

^aProf. Sylvanus P. Thompson, "On Light." 1897.

of generating ultra-violet rays when the tube was placed in circuit with the coil or static machine. These rays have a high efficiency of penetration, and pass thru glass. Many tests to which these ultra-violet rays were put, like with the fluorescent screen made of platino-cyanid of barium or Willemite, gave a highly fluorescent exhibition—even fluorescing thru one-eighth inch to one-quarter inch of glass lenses.⁴

Several photographs were taken by means of these rays with a camera in a dark room. This gave a good test for the rays as to their quality, showing that these active chemical rays, which are known not to pass thru glass, made a fine impression on the photographic plate. Even if the sensitive side of the plate is placed facing the inner side of the camera, and the plain side of the glass toward the lens, the ultra-violet light thus passing first thru the glass lens, and hence to and thru the glass of the plate in order to reach the film, a good picture was always the result.

This again shows that glass is not an entire obstacle to this class of rays, as generated in these tubes. Exploring the spectrum with these rays, we find that they occupy a space high up in the ultra-violet region.

To Professor Henry G. Piffard, of New York, credit should be given regarding some of his excellent experiments on ultra-violet rays and their applications. I take the liberty to quote from his last contribution,⁵ tho I do not agree with his view that the power of these rays to penetrate glass is nil. Others make similar assertions, but, nevertheless, this class of

rays which are generated in vacuum tubes do pass thru glass, as I have shown.

Dr. Piffard says: "Insomuch as the ultra-violet rays are invisible, it may be asked how we determine their presence. In other words, is there any convenient test by means of which their existence or absence may be readily ascertained? One test mentioned by many writers is that performed by aid of the electroscope. If a goldleaf electroscope be charged with negative electricity, the ultra-violet rays will discharge it; but if charged positively, they do not affect it. The most convenient test, however, for the presence of the ultra-violet rays that is known to me is by means of the mineral Willemite, a silicate of zinc (ZnSiO_4), which exposed to the ultra-violet rays exhibits a beautiful greenish fluorescence. If, however, a thin piece of glass, as an ordinary spectacle lens, be interposed between the rays and the mineral, the fluorescence instantly disappears, showing, as already stated, that the rays do not traverse this medium. If, however, a thin quartz plate be substituted for the glass, the fluorescence again becomes apparent.

"If we now expose a piece of Willemite to the x-rays it will fluoresce as before, but the fluorescence will persist even if glass be interposed."

Dr. Leduc, of Paris, observed another source of ultra-violet rays, which, he found, came off from the negative end of a Geissler tube. Professor Piffard found that if a piece of Willemite be placed at the negative end of such a tube it fluoresces, though not vividly, but he says: "This phenomenon is puzzling in view of the fact that the ultra-violet rays are not supposed to traverse glass, and if it, indeed, be those rays that have induced fluorescence, they must have been generated outside of the tube, and be due to the electric stress, with, of course, the proba-

⁴For detail explanation "On Fluorescence," see July number Medical Examiner and Practitioner, "Study on Light," a series of articles, by Dr. J. Mount Bleyer, of New York. 1903.

⁵Radio-Praxis, by Henry G. Piffard, M. D., LL. D., Medical Record, March 7, 1903.

bility that they are not ultra-violet rays." This expression of opinion by Drs. Piffard and Leduc has some weight, but is not conclusive.

I found that all vacuum tubes at a certain degree of vacuum give off ultra-violet rays and x-rays.

I am convinced that what is seen in the form of fluorescence in the low exhausted Crookes tube is not fluorescence, but x-rays of a low degree. Dr. A. Goldhammer strongly advocates this view; he says: "The tendency at present is to believe that the x-rays are waves of ultra-violet light of much smaller dimensions than any that have been hitherto detected." Professor Roentgen's reasons for believing that the new radiations discovered by him were not those of ultra-violet light were as follows:

"(a) The x-rays suffer no refraction in passing from air to water, bisulphid of carbon, aluminum, rock salt, glass, zinc, etc.

"(b) They are not regularly reflected by known bodies.

"(c) They cannot be polarized by known means.

"(d) The density of a body apparently more than any other factor influences their absorption.

"If the x-rays are very short transverse waves of light, which are too small in comparison with unevenness of highly polished substances to be regularly reflected or polarized, b and c can be explained. When we consider also the phenomenon of anomalous refraction and dispersion, the behavior of the so-called x-rays is not so remarkable. Certain substances, like fuchsin and anilin, exhibit anomalous refraction, while substances like glass exhibit normal refraction, the

violet rays being more refracted than the blue rays."

In certain cases of anomalous refraction and dispersion, the amount of refraction (index of refraction diminishes as the length of the wave grows shorter.⁷

Goldhammer therefore concludes that as c can be thus explained by anomalous refraction and dispersion, together with the hypothesis that the x-rays are ordinary transverse vibrations of the ether, such as constitute ordinary ultra-violet light: "The wave length of the x-rays is, however, much smaller than those of any hitherto observed ultra-violet light."

By numerous experiments I found some very peculiar incidents, which agree in many respects with those of Goldhammer. If the hand or finger, or any metallic or other substance is held directly against one of my ultra-violet tubes, the fluorescence which appears over the entire tube will immediately be deflected to one concentrated point. If a platino-cyanid screen then be placed against the deflected point in a dark room, x-rays will show themselves. I am satisfied that all vacuum tubes of either high or low kind will give off x-rays, whether an anode is fixed within or not. The higher the electromotive force employed in experimenting with these vacuum tubes, the larger quantity and quality of the x-rays will be found to exhibit themselves.

I increase the efficiency and regularity of this ultra-violet tube by placing it in circuit either to the static machine or to the induction coil, and attaching a simple apparatus which is made up of multiple gaps. These multiple gaps increase the electromotive force of the current to an enormous degree. The current feels almost the same as from a high frequency

⁷Annalen der Physik und Chemie, No. 4, 1896.

⁷John Trowbridge, S. D., "What is Electricity?" New York, D. Appleton & Co., 1896, The International Scientific Series.

apparatus. Such arrangement is an important piece of mechanism, and will also be found useful for other light frequency work or for vacuum tubes, etc. This multiple spark gap apparatus is here shown in this illustration—also the high frequency tube of my own design. The peculiar style of current of high electro motive character which I generate by these multiple gaps will be found equal to any high frequency current.

Single spark gap attachments are found on many of the so-called high frequency and hyperstatic machines, but I believe I am the first one to utilize the graded multiple spark gaps of from a twentieth to a sixteenth of inch space between the gaps of these apparatuses for therapeutic purposes. These multiple gaps help most wonderfully to raise the electro motive force, and increase the oscillations to a high degree. Nothing will prove the truth of my assertions so much as a practical demonstration with the vacuum tubes which are used for application of the high frequency current.

I present two of my multiple spark gap apparatuses here. One of them is arranged, as seen in the cut, to fit in between the sliding poles of any static machine. The sparking distance is arranged by sliding apart the rods, which then gives any size spark between the rods and the center ball on the spark gap, from which the secondary impulses are then directed down to the grade multiple gaps, which are separated a twentieth of an inch or more. These small graded sparks occur between the rings, which are mounted on a glass rod, and so connected that as many may be thrown into the circuit as wanted. The result attained by such an arrangement is that they give the finest impulses, mostly all of a high frequency quality. These multiple spark gaps are enclosed in a hard rubber case, making

the whole appear like a mounted coil. The entire apparatus may be shifted to any part of the room when not in use, or left connected. The manufacturers are Van Houten & Ten Broek, New York City.

Another important induction coil multiple spark gap mechanism, which I constructed and introduced, is a piece which is made for direct connection to the induction coil. This coil and multiple spark gap has all the qualities that is possibly to be desired for any class of work. The coil, as here illustrated and to which the multiple gaps are attached, is a new model, constructed on entirely new lines, by Dr. Harry Waite. It can be placed in both circuits, alternating or direct.

For these vacuum ultra-violet rays I claim the most remarkable power of penetration, even in semi-opaque substances; and active chemical or photo-chemical action. It is also a cold light, and can be applied to any region of the body, internal or external. It runs noiselessly when connected to static machine or induction coil.

No burns or sparks are left on the patient's skin after any lengthy exposure. It can be operated in most simple fashion by anyone having the slightest experience in x-ray technique, as the method of applying these rays is almost the same.

The construction of these various kinds of tubes differs only in size and pattern; the vacuum is always the same. The life of the tube is long, as it can be operated for hours without deterioration to its rays. When worked with an induction coil for some time, the vacuum is raised, and the ultra-violet rays become changed; so in order to obviate that, a standard regulator is placed on all coil tubes, to lower the vacuum and to bring the ultra-violet rays back to their original state.

While this article was in preparation I still continued experimenting, in order to

produce the best possible ultra-violet tube, which would yield at all times the largest quantity and quality of ultra-violet rays, and hold its vacuum permanently without variation. Mr. Machlett and myself have now produced a tube which has all the best requisites embodied in its construction. I, however, regret that I was just too late to reproduce an illustration of this latest model. A few words will suffice to explain the most salient good points. The tube has no leading inlets or electrodes within the vacuum. The electrodes are made of simple brass band contacts from the outside, and the vacuum is reached by induction. These essential points give the vacuum a long life.

I bring this new method of generating ultra-violet rays to your notice. I do so with the assurance that I am the first to make known the fact that these rays, as I have produced them in vacuum tubes, possess many advantages and no disadvantages as compared with the most costly lamps and complicated accompaniments. There are many different classes of lamps for generating these ultra-violet rays, but I believe there is no lamp which will give a better quality and more quantity of ultra-violet light than this modified Crookes tube. It is with this introduction that this vacuum tube makes its appearance, with a faith and hope that it will prove itself as I present it. Later on I shall take up the study of the physics of the vacuum tubes, which will give you a close insight into its laws, etc.

My experiments are finished, and I turn this tube over to my colleagues for further clinical experience in the various diseases in which the ultra-violet rays are made applicable.

These vacuum ultra-violet generating tubes (Mount Bleyer's) are now found on the market, and made for me in my own patterns and sizes to suit almost all wants. M. E. Machlett & Sons, 143, 145

and 147 East Twenty-third street, have taken much pains in bringing a tube of this character to such a successful issue, that I am indebted to them for their aid, and also to R. Friedlander & Co., Chicago, Ill.

For many scientific researches there is no doubt that quartz and fluor-spar have their prominent places, but for therapeutic purposes these ultra-violet vacuum tubes possess enough of the quality of transmitting the ultra-violet rays thru the walls to warrant their reception as most welcome instruments. I will refer to them later.

Quartz has the power of transmitting the ultra-violet rays far more completely than glass. If, therefore, the glass lens and prism of a projection spectroscope be replaced by a quartz lens and prism, the ultra-violet part of the spectrum is rendered much brighter, and is extended still further than before.

The existing view among physicists, whose authority lends much credit to such views and opinions, is that ultra-violet rays are obstructed by glass. I have, however, for several years, held and based upon authority and upon experimental research, that the ultra-violet rays do pass thru glass. The reader must bear in mind that my work resulted from the discovery of Hertz, that the kathode rays might be transmitted to the outside of the generating discharge tube. Passing from these introductory remarks, the characteristics of the several variety of tubes that I employed will be explained. I made use of several kinds during my experiments, but soon settled down to one; the essential elements of which are shown in the figures. A tube of the kind seen in the illustration was made and connected to an exhaust pump and the air was removed until the ultra-violet ray made itself visible on tests. Opposite the kathode I constructed a window which

consisted of a thin slice or disc of quartz, secured fast by several methods, either of which was sufficient to hold the quartz disc in position. It is called a quartz window. The greater part of this discharge tube (the Mount Bleyer Ultra-Violet Tube) was made of glass. The anode was made from one of the ordinary aluminum discs, seen in all x-ray tubes, and sealed within the discharge tube. The anode and cathode were placed at equal distance, so that the ultra-violet rays were equally distributed. The window was placed in the center of the tube, which is observed plainly in the illustration. The different tubes gave equal results. I found that these ultra-violet rays gave to all the tests known equal quality thru the glass window sides as thru the quartz window. Side by side these comparisons were made, and hardly any difference was possible to be detected.

These quartz window tubes (Mount Bleyer's) will be placed on the market for the sole benefit of those who desire to have quartz lenses and are desirous of testing the difference. (Machlett & Sons, New York.)

But the ultra-violet rays of the spectrum can be seen without the intervention of any fluorescing substance thru a glass or, still better, thru a quartz prism, if the bright part of the spectrum between B and H (Fig. 8) be carefully shut off. With feeble illumination its color appears indigo blue, but with light of greater intensity it is of a bluish gray tint (lavender). The ultra-violet rays thus ordinarily escape observation, because they produce a much feebler impression on the human eye than the less refrangible rays between B and H.

We already have learned to know that there are rays which are still more refrangible than the violet, but which in the ordinary mode of projecting the spectrum are invisible; these are the ultra-violet

rays. They become capable of exciting fluorescence, apparent in any solution, as quinin or esculin, a substance contained in the bark of the horse-chestnut. If sunlight is used for such an examination, the well-known Fraunhofer lines appear upon the bluish ground of the fluorescing spectrum, not only from G to H, but the ultra-violet part appears filled with numerous lines, the most conspicuous of which are indicated by the several letters L to S (Fig. 8). That these lines, like the ordinary Fraunhofer lines, belong properly to solar light and do not depend upon any action of the fluorescing substance is evident from the circumstance that with the electric arc light they are no more apparent in the ultra-violet than in the other colors, and, further, because the same lines are seen in the solar spectrum, whatever may be the fluorescing substance under examination.

An explanation is thus afforded why such a solution as esculin or quinin is colorless when seen by transmitted light, for it absorbs only the feebly luminous violet, and the light that has passed thru it still appears white, and is not rendered materially fainter.

If the solar spectrum be thrown in the above-mentioned manner upon the fluid, its fluorescing part everywhere exhibits the same bluish shimmer; and spectroscopic examination shows that this bluish light has always the same composition, whether it is excited by the G rays, or by the H rays, or by the ultra-violet rays, and that it is formed of a mixture of red, orange, yellow, green and blue. It is thus seen that the different kinds of homogeneous light, so far as they are generally effective, produce compound fluorescent light of identical composition, the constituents of which, nevertheless, are collectively less refrangible than, or are at most equally refrangible with, the exciting rays.

Among other fluorescing bodies may be mentioned the slightly yellow petroleum, with bluish fluorescence, the yellow solution of tumeric with green, and the bright yellow glass containing uranium, which fluoresces with beautiful bright green fluorescence, platino-cyanid of barium, Willemite, and a host of others. Thomas A. Edison has examined over one thousand such materials and myself several hundred, both of a liquid character and in dry state. It admits of very easy demonstration that in these bodies also it is the more refrangible rays that call forth fluorescence. For, if we illuminate them with light which has passed thru a red glass, no trace of fluorescence is visible. But if the red be exchanged for a blue glass, the fluorescence becomes as strongly marked as with the direct solar light. A remarkable phenomenon is presented in the splendid light green light which is emitted by uranium glass under the action of blue illumination. The highest class of fluorescent exhibition can be gotten when the electric arc light is screened over with blue glass. This exhibit I have often showed to scientific men and my own colleagues, with much admiration on their part.

The highly refrangible rays which possess in so high a degree the power of exciting fluorescence, are contained in a large proportion in the light emitted by a Geissler tube filled with rarified nitrogen, or by the ordinary air. In order to expose fluorescing fluids to the influence of this light, the arrangement represented in Fig. 10 may be employed with advantage. A narrower tube is surrounded by a wider glass tube, into which the fluid is introduced by a side opening, and is then closed. Another form of Geissler tube is represented in Fig. 11, which contains in its interior a number of hollow spheres composed of uranium glass. Where a beam of reddish ultra-violet nitrogen light

transverses the tube, the uranium glass balls show with a beautiful bright green fluorescent light. The electric light, passing between the carbon points, is rich in rays of high refrangibility; indeed, the ultra-violet end of its spectrum reaches even farther than that of the solar spectrum. In the light of the magnesium lamp the ultra-violet rays are also abundant, and it has also been shown that in the Welsbach light a large quantity exists. These sources of light are, therefore, particularly well adapted to produce fluorescence, while gas, candle light and the incandescent electric lamps are nearly inoperative on account of the small amount of the more refrangible rays they contain.

It would, nevertheless, be incorrect to infer from the above facts that the more refrangible rays exclusively are capable of exciting fluorescence. An alcoholic solution of naphthaline red in ordinary daylight fluoresces with orange-yellow tints, whose unusual brilliancy will serve to demonstrate that even the lesser refrangible rays are capable of producing this effect. In fact, if the spectrum be projected upon the glass cell containing the fluids (Fig. 9), the yellow fluorescent light will be seen to commence at a point intermediate to C and D, and therefore still in the red, and to extend over the whole remaining spectrum, as far as the ultra-violet. The strongest fluorescence by far is shown behind the D in the greenish-yellow rays. It then again diminishes and becomes a second time more marked between E and B; thence onward, the fluorescence becomes fainter, then increases again in the violet, and gradually vanishes in the ultra-violet. In naphthaline red, therefore, there are rays of lower refrangibility, namely, the green-yellow rays behind the D, by which its fluorescence is most powerfully excited.

(To be continued.)